DOCUMENT RESUME

ED 289 457 IR 012 910

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TITLE A New Era Begins: Satellite Communications and Development.
PUB DATE Sep 87
NOTE 19p.; Paper presented at the Telecommunications Research Policy Conference (15th, Arlie, VA, September 27-30, 1987).
PUB TYPE Information Analyses (070) -- Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Communications Satellites; Costs; *Developing Nations; *Distance Education; Economic Development; *Health Services; Information Systems; International Cooperation; National Programs; *Nonformal Education; *Rural Development; Technological Advancement; Teleconferencing; Telecourses
IDENTIFIERS *Intelsat; Project SHARE

ABSTRACT

This overview of changes in the field of telecommunications development produced by satellite communications over the last 15 years focuses on applications of satellite systems for educational and health purposes in developing countries. Satellite communications development from 1974 to 1986 is identified as the first stage of telecommunications in developing countries, which was generally a trunking network restricted to large cities and beginning with lease or purchase of equipment from INTELSAT. Such projects in Algeria and Brazil are briefly described. A second stage of satellite communications development, which has rural service as an important part of the planning objectives, is also identified and the following topics are addressed in this context: (1) rural satellite communications systems in China and India; (2) new services and low-cost options available through INTELSAT; (3) major studies on the extension of telecommunications systems into rural and remote areas; (4) new digital compression techniques; and (5) cost/benefits of communications development. Guidelines for assessing the level of communications development are suggested. Attachments include lists of countries with INTELSAT leases and purchases; countries with dedicated communications satellite systems; and regional satellite systems. Also attached is a status report for Project SHARE which lists 14 projects together with their sponsors, the participating countries, the type of transmission, and content. (MES)

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A New Era Begins: Satellite Communications and Development

by

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to be presented at

Airlie House
Telecommunications Research Policy Conference

Airlie, Virginia

September 1987

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The last fifteen years in satellite communications has produced some remarkable changes in the field of telecommunications development.

Perhaps, you have seen the Virginia Slims ads "You've come a long way, baby." Well, if you add the phrase, "But you still have a lot further to go," then you will have summed up the situation in the communications satellite development field rather well.

Since the early 1970's the number of dedicated separate satellite systems for national purposes has expanded from nil to ten countries, while 3 and soon 4 regional systems will be serving a large part of the world. Furthermore, we see that the number of

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countries, mostly developing countries, using INTELSAT for domestic purposes has increased from one in 1974 to 31 countries today. The number of earth stations for domestic communications systems in developing countries alone is now numbered in the many thousands with over 2,000 earth stations operating in China and more than 10,000 operating in India. The types of services that are available for rural and remote service has also expanded dramatically. The VISTA rural communiations satellite service uses 4.5 meter earth stations (costing under $60,000) which are now available under a Volume Discount Agreement. VISTA voice service is offered on a circuit by circuit basis on special VISTA space capacity available through the INTELSAT system. INTELNET 1 and 2 data distribution services utilize antennas as small as 65 centimeters and which cost as little as $2,500. There is also a wide variety of very low cost TV receive-only terminals which can be 3 meters in size on up. These can operate in developing countries for TV reception via INTELSAT satellites through leases or purchase arrangements, or with dedicated satellite systems. For dedicated satellite systems, regional systems or INTELSAT provided capacity, domestic application earth stations are typically 3-10 meters in size.

As the size and diversity of the satellite systems in developing countries have grown and expanded, the range of the applications has likewise increased. Today, these systems are heavily used for education. In particular they are used for video and radio tele-education broadcasts. They are also used for interactive audio networks such as used by the University of the South Pacific. These networks are used for general purpose non-formal educational programs for the citizenry. They teach people how to deal with problems of infant feeding formulas, diarrhea, etc. In some countries these can be even used for highly sophisticated applications such as distribution of computer assisted instructional programs to remote personal computer users.

These satellite delivery systems are also extensively used for health applications. Applications include the distribution of tele-medicine information to support medical patients. There is also a wide range of other purposes whereby rural satellite communications can be of great assistance: agricultural applications, emergency communications, disaster and warning systems, environmental information systems, etc. So far in only 2 years alone, 65 countries have benefitted from Project SHARE for remote use of satellite communications for health and education.

In a word we in the world of satellite communications development are beset with "change." Change in satellite technology, change in earth station technology, change in digital communication techniques, and change in applications. Again and again we seem to learn that radio and audio applications are appropriate and effective but that people really seem to want video. Answers, ultimately, must contain the subjective as well as the objective to work for people rather than just institutions.

SATELLITE COMMUNICATIONS DEVELOPMENT: STAGE ONE 1974-1986

In 1973 the INTELSAT Organization created a new domestic lease policy whereby countries could obtain spare capacity from INTELSAT to meet domestic requrements. Algeria was the first country to obtain service from INTELSAT and to create their own domestic system consisting of some 15 earth stations that connected Lakdaria, a suburb of Algiers, with 14 regional capital cities located throughout Algeria. This system which was created at a total cost of only a few million dollars created an instant long distance telephone network and TV distribution network for the country and achieved a more than 95% interconnection capability for all the telephone and television sets in Algeria. It changed Algerian culture instantly. The bazaars were no longer from sunrise to sunset, but from sunrise to the start of the TV transmissions.

Brazil quickly followed suit and created their own national long distance satellite network by leasing capacity from INTELSAT with an initial network of more than twenty earth stations which also achieved close to 90% coverage of all telephone and television sets for the country. This was expanded in the years that followed to a network of over fifty earth stations that provided close to 95% coverage of all telephone and television coverage in Brazil.

In rapid succession a number of other developing countries proceeded to create domestic satellite systems which in many ways followed the Algerian and Brazilian models, namely, interconnecting the major regional cities in the country and providing instantaneously a national telephone network that covered almost all telephones within the country. On a parallel track certain other countries began to consider the launch and deployment of their own dedicated satellite system. The first developing country was Indonesia which deployed the PALAPA satellite system in 1976. Because of the large communications capacity of the dedicated satellite and the higher power levels that were provided the Indonesian satellite system created a very large national TV and telephone network that covered not only regional capital cities but also remote mining, oil drilling and other locations with the initial PALAPA earth station network being comprised of some 40 locations. This number was subsequently expanded to over 100 locations for earth stations. In India the CITE Experiments were carried out with the ATS-5 satellite in the early 1970's which in turn led to the INSAT satellite. Likewise experiments with the ATS-5 satellite in Brazil led to the Brazilsat Program even though an INTELSAT lease proved to be a needed intermediary step.

In the attachments to this paper (see Attachments No. 1 and 2), some information about the communications satellite systems around the world are set forth in terms of the number and distribution of earth stations. Although the greatest number

are shared system networks through the INTELSAT system, dedicated satellite facilities are increasingly popular albeit more so in developed than developing countries. In general, it remains true that virtually all of these satellite systems in developing countries today form a long distance telephone network constituting a trunking system that connect the major cities of the country and also constitute a TV distribution system that follows essentially the same pattern. For the most part, therefore, most of the domestic satellite systems of the world in developing countries at this stage have not made a major incursion into remote and rural areas where telecommunications facilities are generally lacking. Furthermore, for economic reasons lease or purchase of a transponder from INTELSAT to create a basic network is often the only feasible first step. Fortunately we are now entering a new age of telecommunications development via satellite which is going beyond the Stage One type of trunking network restricted to only major cities into Stage Two where rural service is an important part of the planning objectives.

STAGE TWO: A NEW ERA OF SATELLITE COMMUNICATIONS FOR RURAL AND REMOTE AREAS

It is hard to place a precise date on the beginning of what I would call Stage Two of satellite communications development. The INSAT satellite system deployed several years ago in India has a large network of rural and remote communications antennas for development purposes throughout the Subcontinent for both telephone data and especially TV services. This system is probably the most extensive of all developing countries using satellites for rural satellite communicatins and remote TV broadcasting applications. In 1986 China converted from Project SHARE experiments to a dedicated operational National Television University. Today, some 2,000 receive-only terminals are installed for TV distribution in rural and remote parts of China.

These extensive investments in rural and remote telecommunications services by the world's two most populous countries certainly are significant turning points on how satellite communications can be used for social applications as well as general telecommunications development.

Other significant transitions have also occured however, in the last two years within the INTELSAT system. Two new services known as VISTA Thin-Route Communications Services and INTELNET data distribution to microterminals represent significant new options which are now available at low cost to developing countries for rural and remote applications. A volume discount arrangement for the purchase of 4.5 meter VISTA terminals known as Standard D-1 will allow the purchase of such terminals with a basic capability of one telephone channel at a cost of $54,000 (US). It should be noted that this terminal equipped for TV reception and multiple voice channels however, would run somewhat over $100,000 dollars. This option, however, does allow countries who wish to provide facilities in rural and remote areas to consider doing so with investments that are only a fraction of the investments that would have been required a few years ago (see Attachment No. 3).

The INTELNET service also allows for the distribution of data and information to rural and remote areas for such purposes as weather warning, distribution of data to research facilities, agricultural extension centers, schools and colleges, and health clinics and rural hospitals. Utilizing the so called the INTELNET 2 service it is possible to make such data networks interactive and allow remote centers to send back low speed data from remote locations. INTELNET rural and remote data applications allow terminals as small as 65 centimeters and costing only $2,500 (US) including a microprocessor and printer. INTELNET antennas can be set up and established by non-specialists in a relatively short time period, particularly when receive-only terminals are involved. Frequency coordination and registration issues are at a minimum.

INTELSAT's new domestic service offerings include a sale of transponders for planned domestic services which include flexibility to combine international and domestic TV distribution services. All these new services by INTELSAT plus innovations in other satellite systems have promoted a Stage Two development in satellite communications and encouraged new offerings in rural and remote areas. A half dozen countries will soon deploy VISTA terminals and there are another 30 countries that have expressed a preliminary interest in such rural use, either through VISTA or new domestic services for rural and remote applications that go beyond traditional trunking network facilities.

There are several major studies under way about extending telecommunications services into rural and remote areas. Perhaps the most significantly, the RASCOM study sponsored by the ITU is looking at how integrated terrestrial and satellite facilities could respond to the needs of the African continent for telecommunications development. This is particularly critical since the level of telecommunications and development on the African continent represents the area of greatest need on a global basis. Undoubtedly satellite communications facilities will be considered a major part of the this ultimate plan. One option that may be explored is the extension of INTELSAT existing domestic services to a regional basis by creation of a special new arrangement under Article III(e) of the INTELSAT Agreement. At this point it is unclear whether a new regional facility for Africa will be established within the umbrella of the INTELSAT Agreement, whether a separate regional satellite system will be established or whether regional capacity may be made available under the auspices of one or more of major African countries who decide to establish their own domestic satellite systems. Regardless of the outcome, however, one can project a continuation of the Stage Two development whereby new telecommunications facilities provide much more than just interconnection of major cities where

telephone and television sets are already clustered. We will see in the 1990's a new form of rural and remote applications that serves the needs of isolated regions totally without telecommunications or broadcast services today.

It is important to note that the technological innovation that today is especially driving the Stage Two of satellite communications development is in the area of digital compression techniques. In particular, low rate voice encoding at levels of 8-9.6 kbps/s is being explored in land mobile applications. Even 16 and 32 kbps can mean big economies. Further, digital speech interpolation (DSI) which allows a 2.5 time capacity gain adds further benefits. DSI works simply by using the pauses in a telephone conversation. (In a typical telephone conversation each speaker will talk approximately 40% of the time and there will be 20% silence. This means that a particular voice channel will typically only be used 40% of the time. Digital speech interpolation techniques thus assigns a channel only when it is in active use; thus a capacity gain of 2.5 times can be achieved.) These techniques thus will allow the effective cost of telecommunications to be reduced by as much as ten times or even more within the next decade. Many of these techniques are highly appropriate for implementation in rural and remote telecommunications systems and in particular can ultimately allow the use of the INTELNET 2 type of service for a minimal quality voice message type service. The combination of digital compression techniques, low-cost earth station manufacturing techniques, and higher powered satellites with multiple beam configurations should allow a significant level of progress in Stage Two of telecommunications development via satellite in the 1990's.

The educational, health, emergency relief, commercial, and administrative benefits to developing countries of providing rural and remote telecommunications can be enormous in the years ahead. Cost/benefit studies have been done by the ITU

and in particular by such individuals as Charles Jonscher, now of Booz, Allen & Hamilton, and the late Professor Ithiel de Sola Poole of MIT among others which showed that the cost/benefit of communications development in capital cities, in regional cities, and in rural and remote areas vary from 4 to 1 to as much as 100 to 1. In all studies positive cost/benefit ratios have been clearly demonstrated. In developing societies the trade off between travel and telecommunications almost always favors telecommunications particularly when travel is on foot or horse. Although the potential positive applications of communications technologies in rural and remote areas have been discussed on many ocassions and well documented, continuing research supports the value of telecommunications in rural and remote areas. Attachment No. 4 does provide some recent examples of Project SHARE indicating applications that have been made and the benefits that have been derived from these applications in the health and education area.

CONCLUSIONS

In summary, it appears that an important transition has been made approximately in 1985 or 1986. From 1965 to 1985 we had Stage One of satellite communications development, where the focus was on the city. After 1985 to 1986 we have the Second Stage of development where the application of satellite technology in rural and remote areas has now become a significant and growing factor. The transition to Stage Two appears to be a truly significant milestone and the monitoring of this transition should be undertaken in particular to measure the cost and benefits of these new developments and to also monitor the extent, level, and nature of the applications in the various significant categories of education, health, emergency communications, social programs, and economic development.

It is likely that practice will follow the cases of Indonesia and Brazil where economic development projects in areas such as mining, oil drilling, timber and other operations will first drive the Stage Two type development. It seems likely in the 1990's, however, that education, health and other applications will move to the front as the prime need and application in support of rural and remote communications development.

If one were to attempt to develop a crude guideline for satellite communications applications you might apply the following approach in terms of assessing the level of communications development.

	INDEX	TYPICAL APPLICATION
Type I Satellite System	15-30 E/S	Trunk long distance Telecom Network
Type II Satellite System	50-100 E/S	Extended long Distance Telecom Network
Type III Satellite System	500-1000 E/S	Integrated Urban & Rural Telecom Network
Type IV Satellite System	2000+ E/S & TVRO	Intensive Rural Network Coverage

Although these guidelines obviously vary greatly with the size of a country (e.g., they should shrink for Burkina Faso and expand for China) there is today a move beyond Type I and II Satellite Systems to Type III and IV systems. These new systems affect a much broader sector of the population and a

much greater proportion of the country's total geographic area. The trend toward more Type III and Type IV satellite options should be monitored closely and the impact of this new capability on overall economic and social development should be reported as results are known. There is every reason to expect that dramatic developments will indeed be achieved in the next decade. Stage Two constitutes a new beginning.

ATTACHMENT NO. 1

INTELSAT LEASE

COUNTRY	TYPE OF CAPACITY			# OF EARTH STATIONS
	MHz		°E	
Algeria	36	C-Band	66	17
Chile	63	C-Band	332.5	3 and 19 TVRO
China	90	C-Band	66	53 and 2000 TVRO
Colombia	45	C-Band	332.5	14
Denmark (Greenland)	18	C-Band	307	9
France (Fr. Polynesia)	2/5	C-Band	180	5
India	144	C-Band	63	30 and some TVRO
Ivory Coast	9	C-Band	307	3
Libya	36	C-Band	332.5	13
Malaysia	54	C-Band	66	3
Morocco	36	C-Band	307	3
Mozambique	9	C-Band	66	3
New Zealand	18	C-Band	180	2
Niger	36	C-Band	359	2
Nigeria	108	C-Band	332.5	21
Norway	27	C-Band	359	10
Peru	108	C-Band	307	8
South Africa	72	C-Band	63	1 and 19 TVRO
Spain (Canary Is.)	36	C-Band	325.5	2
Sudan	36	C-Band	338.5	15
Thailand	9	C-Band	66	16
United Kingdom	72	Ku-Band	332.5	13 and 49 TVRO
Venezuela	36	C-Band	332.5	1 and 3 TVRO
Zaire	36	C-Band	338.5	16
TOTAL				Approx. 2,300 Earth Stations

INTELSAT TRANSPONDER PURCHASES (BY COUNTRY)

Argentina	144	C-Band	307
Chile	72	C-Band	307
China	144	C-Band	66
Gabon	72	C-Band	359
Germany (FRG)	216	Ku-Band	60
Iran	144	Ku-Band	63
Israel	216	Ku-Band	359
Italy	72	C-Band	359
Niger	36	C-Band	359
Norway	144	Ku-Band	359
Peru	144	C-Band	307
Portugal	36	C-Band	307
Turkey	72	Ku-Band	66
Venezuela	72	C-Band	307

ATTACHMENT NO. 2

COUNTRIES WITH DEDICATED COMMUNICATIONS SATELLITE SYSTEMS

Brazil*	BRAZILSAT
Canada	TELESAT
France	TELECOM and TDF-1
Germany, Federal Republic of	TV SAT (DFS - Pending)
India*	INSAT
Indonesia*	PALAPA-B
Japan	Japan Broadcast Satellite
Mexico	Morelos
United States	Over 20 satellite systems
U.S.S.R.	GHORIZONTS; RADUGA; MOLNIYA

* Developing countries

REGIONAL SATELLITE SYSTEMS

EUTELSAT -- Serving Europe and Providing TV Services to Europe, North Africa and Middle East

ARABSAT -- Serving Middle East and North Africa

PALAPA -- Serving Southeast Asia

PANAMSAT -- (Pending launch within next few months) Would serve Europe, North, Central and South America.

ATTACHMENT NO. 3

COUNTRIES IMPLEMENTING VISTA SERVICE

Bolivia

Guinea

Madagascar

Niue

Sierra Leone

Zaire

ATTACHMENT NO. 4

PROJECT SHARE STATUS REPORT

	SPONSOR	COUNTRIES	TYPE OF TRANSMISSION/CONTENT	CONTENT
1.	World Institute for Freedom of the Press	17 Countries	2 TV transmissions on 17 and 24 July 1985	Health & Education Needs of Women
2.	People's Republic of China, Ministry of P&T, Ministry of Education	China	34 Hours of TV per week for 6 month period	Academic & Cultural programming for national TV University (Program Now An Operational Service as of March 86)
3.	Center for the Advanced Studies of the Americas (CASA); OAS; PAHO; IADB	US & Peru	Teleconference between Wash, DC and Lima, Peru. 17 Sept 85	Discussion of Energy Research & Energy Issues
4.	American Society of Microbiology	Ethiopia; Ghana; Kenya; Nigeria; US	Teleconference between US and multiple locations in Africa. 10 Jan & 14 Mar 86	Applications in Microbiology in Africa including fungal infections, vaccine development, infant diarrhea, and parasitology
5.	Higher Education Development Org. of Ireland	Ireland; Jordan	Series of videoconference exchanges between Ireland and Jordan. Feb-Ap 86	Water management techniques. (Inaugural speeches by King Hussein and Pres. Patrick Hillary of Ireland)

PROJECT SHARE STATUS REPORT

SPONSOR	COUNTRIES	TYPE OF TRANSMISSION/CONTENT	CONTENT
6. Miami Children's Hospital	30 countries in the Americas plus some locations in Europe & Africa	Series of six 12/hr. TV broadcasts with audio return from Jan 86-June 87 (Reached over 40,000 doctors and nurses.)	Telecourses on child survival; pediatrics; child care. (6 Heads of State participated)
7. Memorial Health Science Center,	Canada; Kenya; Tanzania; Uganda and University of the West Indies	Data & Voice links for relay of X-Rays, EKGs; EEGs; medical data for diagnosis. Also for medical education.	Remote medical diagnosis, Medical Education
8. Teleuniversite of Montreal	Costa Rica; Canada;Colombia (& China pending)	2-Way video exchange for educational purposes July & Oct 86	Education and training applications of inter-active videoconferencing
9. The University of the South Pacific	Fiji; Cook Is.; Kiribati; Nauru; Solomon Is.; Tonga; W. Samoa; Vanuatu	Full time audio & data channel. First operational Oct 85. Last extended from Oct 87 to end of Sep 88. Replaced ATS-1 and ATS-3	Wide range of curriculum covering many university courses. Also field extension work & non formal training.
10. Tristar Technologies & CANTO	Jamaica; Trinidad; Barbados; US; Tanzania	Videoconference exchange with Africa	Comparative evaluation of health problems & medical practices

PROJECT SHARE STATUS REPORT

SPONSOR	COUNTRIES	TYPE OF TRANSMISSION/CONTENT	CONTENT
11. ENTEL Peru	Peru	Videonconferences with rural & remote areas of Iquitos, Tacapota, Juanqui, Tocache, Soposa	Medical update courses for remote doctors
12. Pan African News Agency and SONATEL of Senegal	All Africa (originally 5 test countries with Senegal as hub)	Electronic Data Network	African and international news
13. Mexico Council of Hospitals	Mexico and 15 Central & South American countries	Videoconference exchange every Wednesday last Dec 1987	Wide range of health and Medical courses with on Pediatrics
14. Pan American Health Organization; World Health Organization; Maimi Children's Hospital;Abbott Laboratories	30 countries in the Americas	Videoconference with 2-way audio in Spanish & English	AIDS Diagnosis, Pathology and Treatment

PENDING PROJECT ACTIVITIES

° Global Information Services (Global Pacific University

° FISCIT (US to Pakistan Medical Exchange)

° OAS (Education Exchange)